Systemy Logistyczne Wojsk
Zeszyt 58 (2023)
ISSN 1508-5430, s. 111-128
DOI: 10.37055/slw/176014

Instytut Logistyki
Wydział Bezpieczeństwa, Logistyki i Zarządzania
Wojskowa Akademia Techniczna
w Warszawie

Military Logistics Systems
Volume 58 (2023)
ISSN 1508-5430, pp. 111-128
DOI: 10.37055/slw/176014

Institute of Logistics
Faculty of Security, Logistics and Management
Military University of Technology
in Warsaw

Planning and implementation procedures of Armed Forces' transport operations and the safety of the air transport of dangerous goods

Procedury planowania i realizacji operacji transportowych Sił Zbrojnych, a bezpieczeństwo przewozów materiałów niebezpiecznych drogą lotniczą

Marcin Kalbarczyk
kalbar_m@wp.pl; ORCID: 0009-0004-3989-9428
JW. 2305, Poland

Paweł Kler
pawel.kler@wat.edu.pl; ORCID: 0000-0002-8031-723X
Faculty of Security, Logistics and Management, Military University of Technology, Poland

Jan Hlubik
hlubikjan@post.cz; ORCID: 0000-0003-0475-7855
Czech Technical University in Prague, Czech Republic

Katarzyna Lipińska
k.lipinska@akademia.mil.pl; ORCID: 0009-0003-0757-9780
War Studies University, Poland

Abstract. Military air transport is a specialized transport service that requires a selection of the appropriate means of transport and careful planning of the mission. This becomes particularly important in the era of the Armed Forces activity in international unions such as the European Union or the North Atlantic Alliance, including the logistical support of the Ukrainian army with the Russian Federation beyond our eastern border. Military operations outside the country require the movement of components designated for the implementation of tasks over long distances while ensuring a short time of movement and the

safety of personnel, equipment, and other materials. Such parameters can be guaranteed by air transport carried out by organic military means of transport and by contracting services on the civil market. The analysis carried out in the publication and its results complement the whole research in the area of safety of transport of hazardous materials by air. At the same time, they complement the research niche in the area of procedures for planning and implementing transport operations of the Armed Forces.
The aim of this article is to present the practical aspects of the issues related to the transport of hazardous materials by aircraft and to verify the problem in the form of the following question: Do the current legal conditions and applicable procedures ensure the safe transport of hazardous materials by aircraft? For the purposes of this publication, the following hypothesis was adopted: Current procedures and legal regulations ensure timely and safe transport of hazardous materials by aircraft under the jurisdiction of not only the Armed Forces.
Verifying the adopted hypothesis required the use of several appropriately selected research methods, the main of which should be distinguished: analysis of documents, synthesis, case study and inference. The presented analysis of normative documents and procedures related to the preparation of cargo allows to state unequivocally that the transportation of hazardous materials by aircraft can be carried out in an organized and relatively safe manner. However, the determinant ensuring transport safety is strict compliance with legal regulations and procedures.
Keywords: hazardous materials, safety, air transportation, supply chain, Armed Forces

Abstrakt. Wojskowy transport lotniczy to specjalistyczna usługa transportowa, która wymaga doboru odpowiedniego środka przewozu oraz starannego przeprowadzenia procesu planowania misji transportowej. Nabiera to szczególnego znaczenia w dobie aktywności Sił Zbrojnych w układach międzynarodowych, takich jak Unia Europejska, czy Sojusz Północnoatlantycki, w tym wsparcia logistycznego wojsk Ukrainy z Federacją Rosyjską za naszą wschodnią granicą. Działania militarne poza granicami kraju wymagają transportu komponentów wyznaczonych do realizacji zadań na znaczne odległości przy jednoczesnym zapewnieniu krótkiego czasu przemieszczenia oraz bezpieczeństwa stanów osobowych, a także sprzętu i materiałów. Niewątpliwie parametry takie są w stanie zagwarantować transport lotniczy realizowany organicznymi wojskowymi środkami transportowymi oraz poprzez kontraktowanie usług na rynku cywilnym. Celem artykułu jest przybliżenie praktycznych aspektów problematyki związanej z przewozem materiałów niebezpiecznych statkami powietrznymi oraz weryfikacja problemu w postaci następującego pytania: Czy obecne uwarunkowania prawne i obowiązujące procedury zapewniają bezpieczne przemieszczanie materiałów niebezpiecznych statkami powietrznymi? Na potrzeby niniejszej publikacji przyjęto hipotezę w następującej postaci: Obecne procedury i regulacje prawne zapewniają terminowy i bezpieczny transport materiałów niebezpiecznych statkami powietrznymi pozostającymi w jurysdykcji nie tylko SZRP.
Weryfikacja przyjętej hipotezy wymagała zastosowania szeregu odpowiednio dobranych metod badawczych, z których jako główne wyróżnić należy: analizę dokumentów, syntezę, studium przypadku oraz wnioskowanie.
Słowa kluczowe: materiały niebezpieczne, bezpieczeństwo, transport lotniczy, łańcuch dostaw, Siły Zbrojne

Introduction

The Armed Forces of the Republic of Poland have been participating in military operations on the international arena since almost the middle of the 20th century. This activity has been particularly visible since Poland joined the structures of the NATO North Atlantic Treaty Organization and the European Union. Membership in the most powerful military alliance in the world gave Poland a guarantee of security in the form of art. 5 of the Washington Treaty, which talks about mutual assistance of the member states of the North Atlantic Treaty in the event of an armed attack on one of them. In such a case, NATO States shall take all measures to restore

the security of the NATO area, including the use of armed force. In addition, the acquisition of the membership of the North Atlantic Alliance led to the growth of Poland's position and importance on the international arena. The need to adapt structures and procedures to NATO standards, the participation of Polish soldiers in missions and exercises and trainings with soldiers from other NATO countries caused that our Armed Forces achieved a high level of interoperability (ability to cooperate) with other Allied troops (bbn.gov.pl, 2023). Participation in international missions and training projects is undoubtedly an invaluable source of experience, however, it poses additional challenges for the Polish Armed Forces in the form of logistic support of the components allocated for the implementation of operational tasks. Due to the distance from the place of permanent dislocation, the logistics support process is always consolidated with the need to implement a supply chain for the theatre of activities.

When analyzing the activity of the Polish Armed Forces on the international arena and the available transportation options, it should be stated that the fastest and most reliable way to transport people and goods over long distances is the air transportation. Given the limited possibilities in the field of strategic air transportation of the Polish army, it may be crucial to start procedures related to the planning of means of transportation, especially those obtained outside the Polish Armed Forces, in advance. In this situation, participation in international transport programs and contracting transport units on the civil market are invaluable. It should be remembered that the performance of tasks by the Polish Armed Forces outside the country has many specific features, such as different terrain and climatic and environmental conditions, or functioning in the area of military threat, which is why civilian transportation units cannot always or want to carry out transportation missions for the army in areas subject to armed conflict.

The movement of personnel and general equipment and materials over long distances is based on three methods of transportation:

- using military aircraft type C-295M CASA and C-130 HERCULES;
- contracting transport services on the civil market;
- by participating in international transport programs.

In practice, international transport programs such as SALIS (Strategic Air Lift Interim Solution) and SAC (Strategic Airlift Capability) are often used in the process of moving Armed Forces of the Republic of Poland components over long distances, as part of which large-size AN-124 Ruslan and Boeing C-17 Globemaster III aircraft are used. Such a solution undoubtedly complements the transport capabilities of the Armed Forces of the Republic of Poland during the movement of more people and equipment to distant theatres of operations.

The transportation of hazardous materials is also a very important aspect, which in the case of military operations is of particular importance due to the need of supplying soldiers with equipment and materials that, according to legal

regulations, are often perceived as dangerous, such as ammunition, explosives, as well as motor vehicle fuels.

Due to the fact that transportation of hazardous materials is often of key importance, both for the safety of soldiers and for the implementation of tasks in the area of military responsibility, such transportation should be characterized by high efficiency and, in some cases, the effectiveness of the supply chain.

The aim of the article is to present the practical aspects of the issues related to the transport of hazardous materials by aircraft. The main research problem is the verification of the issue in the form of the following question: do the current legal conditions and applicable procedures ensure the safe transport of hazardous materials by aircraft? For the purposes of this publication, the following hypothesis was formulated: current procedures and legal regulations ensure timely and safe transport of hazardous materials by aircraft under the jurisdiction of not only the armed forces.

Verifying the adopted hypothesis required the use of several appropriately selected research methods, the main of which should be distinguished: analysis of documents, synthesis, case study and inference.

The presented publication is a comprehensive analysis associated with both theoretical and practical issues related to the safety of the transport of hazardous materials, so it can be the basis for further, more detailed research aimed at ensuring the safety of the transport of hazardous materials.

Therefore, the article analyzes the area of transportation of hazardous materials in terms of human safety and transported property.

Literature review

In order to fully understand this issue, it is necessary to clarify the concept of "hazardous materials" in air transportation.

Hazardous materials are objects or substances that are capable of creating a significant risk to human health or life, or to the safety of property during the air transportation. Dangerous materials can be everyday objects such as dry ice, aerosols and perfumes, bleachers, batteries, glues and many other items that do not raise our concerns during their use on a daily basis (ulc.gov.pl, 2023). In the case of military air transportation, the situation becomes much more complicated due to the fact that military property and equipment such as: vehicles, weapons and ammunition or large amounts of explosives are often transported. Failure to comply with safety procedures during the organization and implementation of the transfer may result in much more serious consequences than the transportation of everyday materials in civil aircraft of airlines.

The carriage of dangerous goods by air, whether by military or civilian means of transport, is subject to strict legal regulations, both national and international.

The Convention on International Civil Aviation was signed in Chicago on December 7, 1944. – Chicago Convention (Journal of Laws of 1959, No. 35, item 212, as amended) (ulc.gov.pl, 2023). It should be emphasized that since then, in connection with the development of civil aviation and the continuous increase in the level of flight safety, the Convention has created 19 annexes addressing the issues of the organization and safety of flights in practically all its areas. From the point of view of the issues discussed in the article, it is worth mentioning Annex No. 18 "Safe transportation of hazardous materials by air" developed on the basis of the recommendations of the United Nations Committee of Experts on the Transportation of Hazardous Materials and the provisions of the International Atomic Energy Agency on the Safe Transportation of Radioactive Materials.

In the case of the organization and implementation of the movement within the country, one of the main documents referring to the movement of dangerous goods is the Act of August 5, 2022 on the transportation of dangerous materials by air. This Act lays down the rules for the operation of domestic and international transportation of dangerous goods by air using civil aircraft, for the carriage of dangerous goods by passengers or crew members of aircraft, and for bodies and entities carrying out tasks related to such transportation and carriage (Act of August 5, 2022, art.1). The implementation of the relocation under the jurisdiction of the Armed Forces of the Republic of Poland is subject to additional legal regulations. The main document is the "Rules for the carriage of troops and military equipment by air" DD-4.4.2 (B), in which the aim is to define the procedures for the planning and implementation of military transportation by air (from military and civilian airports), in order to minimize the associated threats and ensure the necessary degree of safety and uniformity, as well as to determine the scope of responsibility of organizational units (cells) and officers involved in this process (DD 4.4.2(B), 2020, p. 9). "Instructions for the transportation of dangerous materials by military aircraft" DU-4.4.2.1 (A) deals in more detail with issues related to the transportation of dangerous materials by air and also applies only to the process of movement carried out by aircraft belonging to the Polish Armed Forces. This manual was developed on the basis of the provisions on the movement of equipment by military aircraft of the United States Air Force (AFMAN, 2017, p. 7).

This manual specifies in detail the procedures for all aspects of the transportation of dangerous goods using aircraft of the Polish Armed Forces in order to minimize hazards and ensure the necessary degree of safety and uniformity. It also aims to provide information on the rules and procedures of air transportation of hazardous materials and the division of tasks and competences for organizational units of the Ministry of National Defence and military units of the Polish Armed Forces responsible for their planning and implementation (DU-4.4.2.1(A), 2020, p. 9).

It should be stressed that all national provisions should be kept up to date and adapted to the documents in force during the organization of an international movement. The main organization defining legal regulations at the international level is the International Civil Aviation Organization (ICAO), which deals with the development and implementation of international regulations on the movement of aircraft on the international arena and the development of international air navigation. In order to ensure the efficient and safe implementation of the movement of dangerous goods by air, ICAO has issued, and is updating on an ongoing basis, technical instructions for the safe transportation of dangerous goods by air. These conditions are the basis of the regulations enforced by the International Air Transport Association IATA.

These regulations are tailored to the individual requirements of individual governments and airlines. Regardless of the destination, the shipment must comply with the DGR (Dangerous Goods Regulations)– with the regulations for the transportation of dangerous goods established by IATA (langowski.eu, 2023).

It is also worth emphasizing that air transportation is undoubtedly subject to the greatest restrictions in terms of the type and amount of hazardous materials allowed for transportation.

In 2022, the International Air Transport Association (IATA), where over 300 airlines are registered, constituting about 83% of all carriers, published a report on the number of aircraft accidents resulting in the death of passengers or crew. It is estimated that over 1/3 of all flights contained hazardous materials. For the purpose of the article, the results of the report were compared with the data obtained from the Civil Aviation Authority (ULC) on air disasters caused by hazardous materials on board aircraft. The results of the comparison are shown in the table below:

Table 1. Comparison of the IATA report with the CAA data on air disasters

No.	Year	Accident rate for one million flights	Number of air accidents	Number of aviation accidents involving dangerous materials
1.	2022	0.16	5	1
2.	2021	0.27	5	-
3.	2018-2020	1.13	7	-

Source: Authors' own compilation

In order to fully illustrate the state of safety related to the transport of hazardous materials by aircraft, the list of air accidents involving explosives from 1980 to the present is presented below.

Table 2. List of air accidents involving dangerous materials

No.	Year	Place of the accident	The cause of the disaster
1.	1980	Saudi Arabia	Self-ignition of flammable materials in the cargo hold
2.	1996	Miami /USA/	Activation of chemical oxygen generators (incorrect load securing)
3.	1996	New York /USA/	Self-ignition of lithium-ion batteries
4.	2006	Philadelphia /USA/	Self-ignition of lithium-ion batteries
5.	2010	Dubai /United Arab Emirates/	Self-ignition of lithium-ion batteries
6.	2011	South China Sea	Self-ignition of lithium-ion batteries
7.	2013	Dubai /United Arab Emirates/	Self-ignition of lithium-ion batteries
8.	2013	Bagram /Afghanistan/	Incorrect cargo securing (movement of cargo during the flight)
9.	2022	Kavala /Greece/	Undetermined. However, about 11,5 tons of weapons and other dangerous materials were on board

Source: Authors' own compilation

Analyzing the number of disasters involving hazardous materials in relation to its total number, it can be observed that it constitutes a small percentage of the total. Therefore, it can be unequivocally stated that the normative documents and applicable procedures ensure the safety of transporting hazardous materials by air. Nevertheless, when looking for the causes of the discussed air disasters, it can be observed that a significant threat is posed by lithium-ion batteries, which are an article of common use. Therefore, despite restrictive regulations, the solutions ensuring the safety of people, aircraft and transported property should be constantly analyzed and improved as experience is gained.

Safety of the preparation and loading of hazardous materials on air transport means

In day-to-day aviation practice, flight safety is understood as the totality of properties preventing emergencies and the possibility of maximally reducing the consequences of such situations by applying appropriate systems protecting human health and life, both on board the aircraft and within the entire airport (Żelazo,

2016, p. 180). Transporting hazardous materials by air carries a high risk and a high probability of an accident resulting in damage to the transported assortment, aircraft, and even human health or life in the event of an air crash. Therefore, during the preparation of the shipment, priority should be given to all issues related to ensuring safety, from the choice of means of transport and transport planning, to the implementation of the shipment and to safe unloading at the destination.

In order to ensure safe movement, hazardous materials have been divided into 9 main classes (ICAO, 2022):

I. Explosives
II. Gases
III. Flammable liquids
IV. Flammable solids, pyrophoric materials and materials producing flammable gases in contact with water
V. Oxidizing materials and organic peroxides
VI. Toxic materials and infectious materials
VII. Radioactive materials
VIII. Corrosive materials and substances
IX. Other hazardous materials, including hazardous substances for the environment.

It should be emphasized that only the basic classes of hazardous materials are listed for the purposes of this article. In order to ensure the full spectrum of safety, these classes have been subdivided into subclasses that define in detail the types of hazardous materials so that they can be assigned uniformly to a given class and then properly prepared for transportation. It is also important to note that according to ICAO regulations, it is forbidden to carry certain classes of dangerous goods within one aircraft or to transport certain dangerous goods with personnel. Such an example may be some explosives, together with initiating devices (detonators), the transportation of which in one means of transport is prohibited. It is also worth noting that these provisions take into account deviations from the established rules that apply in the event of emergencies, special and combat conditions, but they require the written consent of the Minister of National Defence. An example of such a situation may be the transportation of ammunition and explosives in war conditions, where the compatibility of the classes of materials moved is not taken into account in justified cases, or the transportation of people with cargo marked as "cargo aircraft only". Such a solution is used only in justified cases and does not exempt the carrier from having the required transport consents and a set of appropriate transport documentation, such as:

- a list of passengers for the aircraft, together with their personal data, in the case of carriage of headcounts;
- a declaration of the transportation of dangerous goods;

- export-import customs declaration for goods which are the property of the armed forces;
- a declaration of cargo carried (Cargo Manifest) with a detailed indication of the property carried;
- diplomatic authorizations obtained from transit and destination states for the flight of their airspace;
- a certificate for the master of the aircraft to verify the cargo on the aircraft and its compliance with the documentation.

When issuing exemptions from the provisions of the "Manual for the Carriage of Dangerous Goods", the principle of maximum safety for aircraft and personnel should be followed. Exemptions must not be granted in order to facilitate the operation, e.g. if there is an alternative method of transport (road or rail transport), or the convenience of the persons involved. When issuing an exemption, the authorities authorized to do so are guided only by ensuring safety and minimizing the risk in the event of threats (DD 4.4.2(A), p. 28).

The improvement of the quality of transport services provided, and at the same time the increase in the level of safety, is also influenced by the appropriate packaging and marking of the transported dangerous materials. This becomes important in the event of hazards such as explosion, fire or radiation. Therefore, it should be remembered that during the preparation of hazardous materials for loading on aircraft, there is a requirement to use certain packaging only – and to do so only with an appropriate certificate.

Characterizing the transportation of hazardous materials, it is impossible not to mention its impact on the environment, where any failure to comply with the procedures may have significant repercussions for the environment. From the analyses of hazardous situations in transportation, it can be concluded that the main source of the hazard is the passage itself and loading and unloading, which, in the event of irregularities, brings about the entry of the dangerous substance into the surrounding environment, causing a toxic, fire, chemical or explosive hazard (Brodzik, 2020, p. 19).

Calculations for the transportation of hazardous goods by military aircraft

Ensuring the safety of transportation of hazardous materials by aircraft due to the catastrophic consequences in the event of accidents and other negative events is extremely important. In order to raise awareness of the complexity of the discussed issue and its multifaceted nature, an exemplary process of planning the movement

of hazardous materials by air was carried out. For the purposes of this Article, the movement of the following hazardous materials was planned:

- A HUMVEE belonging to the Armed Forces of the Republic of Poland (UN 0339, Class 9) with a weight of about 4,500 kg;
- 100 ammunition boxes 7.72 mm for the AKMS rifle (UN 0012, class 1.4s) weighing approx. 3,000 kg;
- 100 ammunition boxes for a pistol (UN 0012, class 1.4s) weighing approx. 1,500 kg;
- 1 air pallet with soldiers' equipment, not containing hazardous materials with a total weight of 4.5 tons.

The transfer of the above-mentioned assortment will be carried out from the airport of the 8th Transport Aviation Base in Wrocław, to the airport at the Ivory Coast, located more than 8000 km from the loading airport.

First of all, knowing the type of cargo being moved, its weight and dimensions, the most optimal means of transport must be chosen. Taking into account the specificity of the Armed Forces of the Republic of Poland, it is possible to use three available options:

- the use of military aircraft (C-295M CASA, C-130 HERCULES) – which is undoubtedly the most economical solution;
- use of the services of international transport programs of which the Armed Forces of the Republic of Poland is an active participant. In this case, the transport services are carried out by large aircraft: C-17 GLOBEMASTER under the SAC program and AN-124 RUSLAN under the SALIS program;
- commissioning a transport service to a civilian external company – which is the least economical solution due to the high costs generated by private transport companies, however, the carrier assumes all responsibility for the entrusted property.

Table 3. List of transport possibilities of available aircraft

Type of aircraft	Tonnage [kg]	Reach [km]	Cruising speed [km/h]
C-295M CASA	9,250	2,300	480
C-130 HERCULES	20,000	3,800	540
AN-124 RUSLAN	120,000	16,090	750
C-17 GLOBEMASTER	77,519	8,740	830

Source: Authors' own compilation

Comparing the parameters of the available aircraft, it can be unequivocally stated that the most optimal solution, from the point of view of the costs incurred and the use of cargo space, will be the selection of a C-130 HERCULES aircraft belonging to the Armed Forces of the Republic of Poland.

The next stage of transport preparation is the calculation of the center of gravity for the vehicle being moved, which, due to the content of fuel, batteries and fire extinguisher, is also classified as a hazardous material. Pressure changes cause changes in fuel volume, so it should be remembered that the vehicle must contain only a minimum amount of fuel to reach the nearest fuel station after landing (on average, 1/3 of the tank is accepted). The center of gravity shall be calculated according to the following algorithm:

First, we calculate the load on the axles of the vehicle according to the formulas:

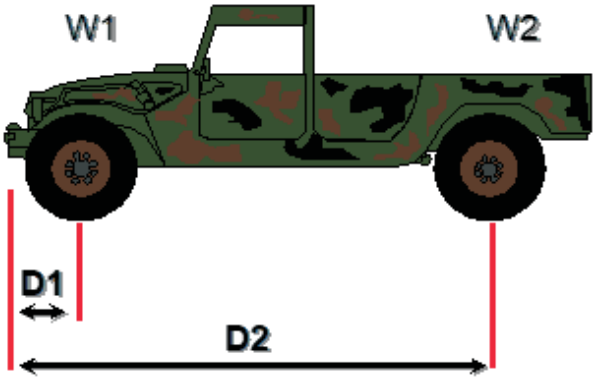


Fig. 1. Calculation the center of gravity

Source: Own elaboration based on AMC Affiliated contingency load planning workbook 36-101

$$M1 = W1[kg]xD1[inch] \tag{1}$$

$$M2 = W2[kg]xD2[inch] \tag{2}$$

Where:

M1 – moment of force of the first axis
M2 – moment of force of the second axis
W1 – pressure on the first axle of the vehicle
W2 – pressure on the second axle of the vehicle
D1 – distance from the front of the vehicle to the first axle
D2 – distance from the front of the vehicle to the second axle

The total moment of force is determined from the formula:

$$M = \frac{M1 + M2}{W1 + W2} \tag{3}$$

For this example, the center of gravity calculation will be as follows:

$$M1 = W1 \text{ x } D1 = 1400 \text{ [kg] x } 25 \text{ [inches]} = 35000 \text{ [kg x inch]} \tag{4}$$

$$M2 = W2 \text{ x } D2 = 1050 \text{ [kg] x } 97 \text{ [inches]} = 101850 \text{ [kg x inch]} \tag{5}$$

$$M = \frac{M1 + M2}{W1 + W2} = \frac{35000\left[\text{kg x inch}\right] + 101850\left[\text{kg x inch}\right]}{1400\left[\text{kg}\right] + 1050\left[\text{kg}\right]} = \\ = \frac{136850\left[\text{kg x inch}\right]}{2450\left[\text{kg}\right]} = 56\left[\text{inches}\right] \tag{6}$$

The calculations show that the center of gravity of the vehicle falls at a distance of 56 inches from the front of the vehicle.

In the case of ammunition, calculate the quantity of hazardous material in the transported quantity of ammunition from the following formula:

$$NEW = NEW(1) \text{ x } N + NEW(2) \text{ x } N \tag{7}$$

where:
NEW – quantity of hazardous material of all ammunition,
NEW(1)/NEW(2) – quantity of hazardous material in one box of ammunition (the value is read from the tables contained in the instructions or directly from the ammunition boxes),
N – quantity of ammunition (boxes).

For the purpose of the prepared shipment, the amount of hazardous material is:

– for 7.62 mm ammunition:

$$NEW1 = 2.8\text{[kg/box]} \text{ x } 100\text{[boxes]} = 280\text{[kg]} \tag{8}$$

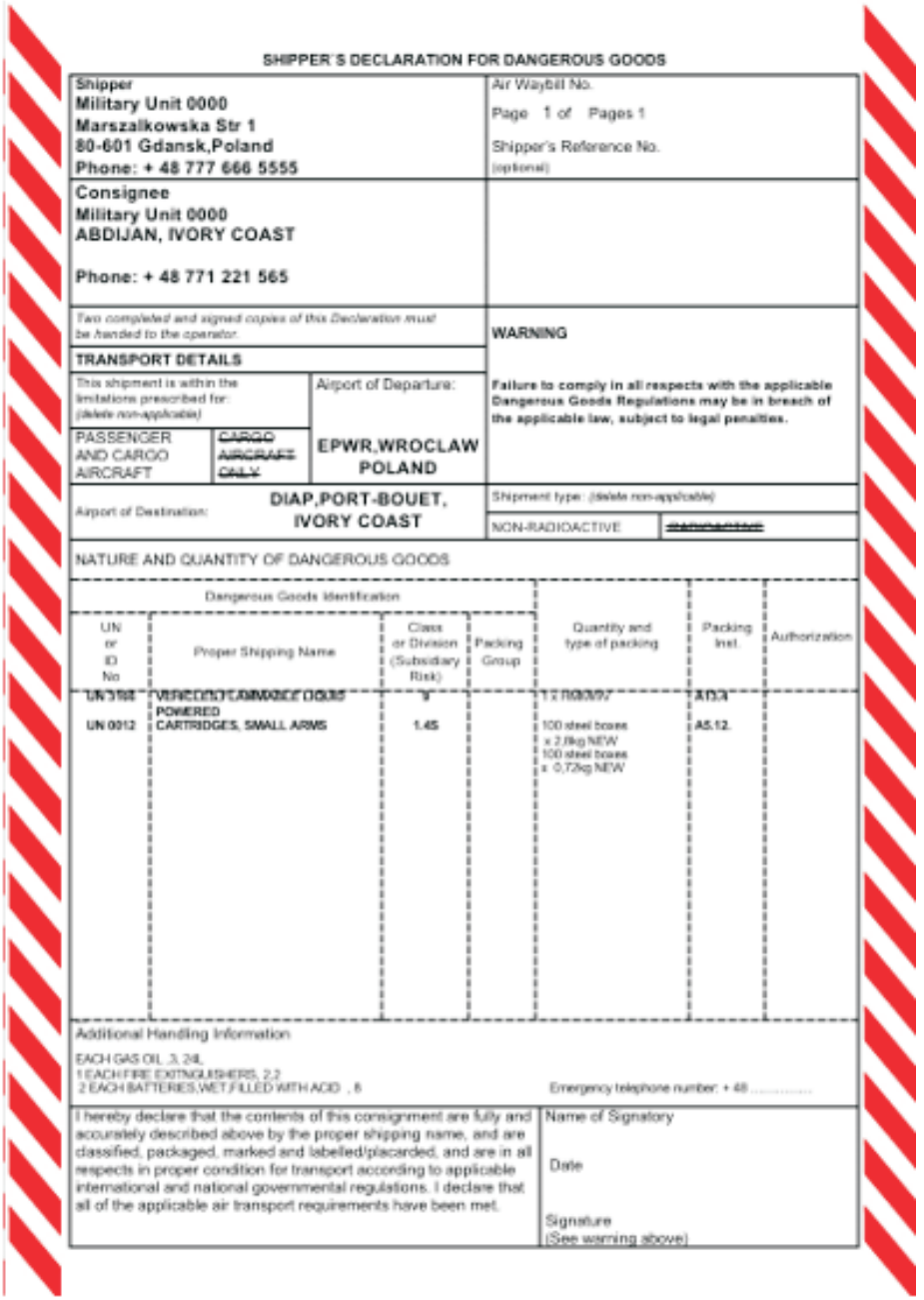
– for 9mm ammunition:

$$NEW2 = 0.72\text{[kg/box]} \text{ x } 100\text{[boxes]} = 72 \text{ [kg]} \tag{9}$$

The calculations show that the total weight of hazardous material in ammunition is:

$$NEW = NEW1 + NEW2 = 280\text{[kg]} + 72\text{[kg]} = 352 \text{ [kg]} \tag{10}$$

On the basis of the calculations carried out, a declaration of the transportation of hazardous materials should be made:



SHIPPER'S DECLARATION FOR DANGEROUS GOODS

Shipper **Military Unit 0000** **Marszalkowska Str 1** **80-601 Gdansk,Poland** **Phone: + 48 777 666 5555**	Air Waybill No. Page 1 of Pages 1 Shipper's Reference No. (optional)
Consignee **Military Unit 0000** **ABDIJAN, IVORY COAST** **Phone: + 48 771 221 565**	
Two completed and signed copies of this Declaration must be handed to the operator.	**WARNING**
TRANSPORT DETAILS	
This shipment is within the limitations prescribed for: *(delete non-applicable)* PASSENGER AND CARGO AIRCRAFT / ~~CARGO AIRCRAFT ONLY~~ Airport of Departure: **EPWR,WROCLAW POLAND**	**Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties.**
Airport of Destination: **DIAP,PORT-BOUET, IVORY COAST**	Shipment type: *(delete non-applicable)* NON-RADIOACTIVE / ~~RADIOACTIVE~~

NATURE AND QUANTITY OF DANGEROUS GOODS

Dangerous Goods Identification				Quantity and type of packing	Packing Inst.	Authorization
UN or ID No	Proper Shipping Name	Class or Division (Subsidiary Risk)	Packing Group			
~~UN 3166~~	~~VEHICLES, COMBUSTION ENGINE~~	~~9~~		~~1 x 1000KG~~	~~A163~~	
UN 0012	POWERED CARTRIDGES, SMALL ARMS	1.4S		100 steel boxes x 2,7kg NEW 100 steel boxes x 0,72kg NEW	A5,12.	

Additional Handling Information

EACH GAS OIL, 3, 2dl,
1 EACH FIRE EXTINGUISHERS, 2,2
2 EACH BATTERIES,WET,FILLED WITH ACID , 8

Emergency telephone number: + 48 .....

I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labelled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. I declare that all of the applicable air transport requirements have been met.	Name of Signatory Date Signature (See warning above)

Fig. 2. Declaration of the transportation of hazardous materials for the example in question

Source: Own elaboration based on the current formula and consultation with 8 BLT Wroclaw specialists

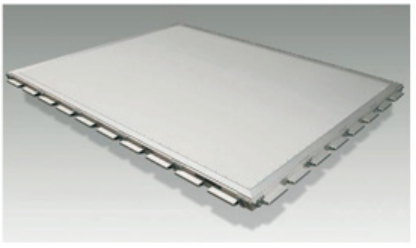
A very important element in the preparation of dangerous goods for transportation is its marking. At this point, it should be mentioned that each package containing hazardous material must be properly labelled. In accordance with the regulations, it should be a marking of specified dimensions (10x10cm) and color with the indication of the class of hazardous material. For the purposes of this Article, these shall be the following indications':

Marking of ammunition

Marking of vehicle

Fig. 3. Marking of hazardous materials being moved

Source: Own elaboration based on the "Instructions for transportation of hazardous materials by military aircraft" DD-4.4.2.1 (A)



Air Pallet HCU6E

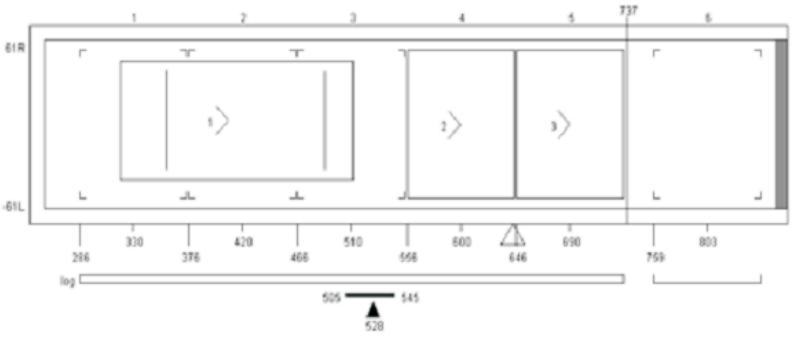
Air Pallet HCU6E
with, for example, a formed load

Fig. 4. Forming cargo on an air pallet

Source: DD-4.4.8 (B), Rules for the use of pallets and containers in the Armed Forces of the Republic of Poland, Warsaw 2017 p. 1011

After proper preparation of the cargo, it should be placed on air pallets, the construction of which allows for the interconnection important in the transportation of oversize cargo. The following shall be used to protect the loading units against damage during transportation, handling and storage (Kalbarczyk, Kler, 2019, p. 32):

- special safety nets;
- ribbons or belts;
- shrink-wrap or stretch-wrap;
- covers.



SQ/D	TCN/Pallet ID	Bumper	Model/Nomenclature	LEN	WDT	HT	WT	FSN	TSN	CB	HZ	FL	V	D	SH	CCC
1/M			HMMWV	191	86	72	4500	320	511	408	n	E	N	A		R2D
2/M			463L/Military equipment	88	108	62	5000	556	644	600	n	E	N	A		J3B
3/M			463L/Military equipment	88	108	62	4500	646	734	690	y	E	N	A		J3B

Total # of Pax: 0 Weight/Pax: 210 Total Pax Weight: 0
Total # of Subfloors:0 Weight/Subfloor: 0 Total Subfloor Weight: 0
Total Cargo Wt: 14000 Total Load Wt: 18620 ACL: 25000
%ACL: 74 %ZF: 0 Load CB: 528

SQ/D Flags/Warnings

SQ/D Class/Zone
3/M 1.4S

ALL HAZARDOUS MATERIALS COVERED BY THIS MANIFEST HAVE BEEN INSPECTED AND FOUND TO BE PACKAGED IN THE PROPER OUTSIDE CONTAINER, FREE OF VISIBLE DAMAGE AND LEAKS AND IS PROPERLY CERTIFIED

_____
Air Terminal Representative Signature

I HAVE BEEN BRIEFED ACCORDING TO AFJMAN 24-206, PARAGRAPH 1.2.9, ON HAZARDOUS CARGO COVERED BY THIS MANIFEST

_____
Aircraft Crewmember Signature

Load planned by : _____ Date: _____

Load approved by: _____ Date: _____

Fig. 5. Aircraft loading plan C-130 made in the AALPS IT system
Source: AALPS IT system

In addition to the specially prepared cargo, the crew of the aircraft is also required to have a complete set of documentation, which is presented during customs operations - in the destination country and in transit countries. An inconvenience in the preparation of documentation is the requirement for some countries to have

documentation in their native language, despite the fact that the airport service in the transit or destination country is fluent in English.

One of the most important aspects affecting transport safety is the proper distribution of cargo in the aircraft, the so-called "Load plan". This translates not only into the optimal use of cargo space, but also fuel consumption and flight time, but, above all, directly affects the safety of people and freight in the event of unforeseen situations, such as emergency landing, turbulence or extreme weather conditions. In the process of preparing a cargo deployment plan on board an aircraft, information systems such as, for example, ICODE or AALPS are utilized. These are programs that have parameters of various aircraft, including the size of their decks. After entering all parameters of individual loads, the program automatically selects the optimal freight setting on board the aircraft. For the analyzed example, the following is the loading plan made in the AALPS IT system:

It should be remembered that the preparation of hazardous materials must be carried out by specialists with appropriate practical knowledge and the required authorizations to make and sign declarations for the transport of hazardous materials. Such privileges are acquired during specialized training and end with a theoretical and practical exam. Due to the continuous acquisition of experience and the emergence of new hazardous materials and thus the evaluation of regulations in this area, such training must be repeated with frequency every two years.

It should be emphasized that all provisions concerning the organization and implementation of the movement of hazardous materials are strictly observed and that high financial penalties are imposed for any breaches in this regard.

Conclusions

The main aim of the article was to obtain an answer to the question: do the current legal conditions allow for the safe movement of hazardous materials by air transport? The article presents the process of planning the transportation of hazardous materials by military aircraft, starting from the analysis of reference documents regulating transport activities, to the characteristics of the process of preparing the cargo for transport. In addition, an example calculation of the movement of hazardous materials from the Ivory Coast is presented. It should be noted, however, that this was not a process of preparing the displacement in its full spectrum. The focus was only on activities related to the preparation of hazardous materials. For the purposes of the article, processes such as determining the flight route, stopping to refuel, obtaining diplomatic approvals for passage through transit countries, or preparing full documentation required during customs operations were omitted.

Ensuring efficient, timely and safe transportation of hazardous materials is an extremely complex process. Nevertheless, the presented analysis of normative documents and procedures related to the preparation of cargo allows to state unequivocally that the transportation of hazardous materials by aircraft can be carried out in an organized and relatively safe manner. However, the determinant ensuring transport safety is strict compliance with legal regulations and procedures, such as:

- proper classification and separation of hazardous materials;
- the properly carried out process of packing and loading the aircraft;
- periodic referral to courses and training of personnel responsible for the preparation of dangerous goods for transport.

In support of the stated thesis, it is also possible to cite the continuous updating of international IATA regulations and the compatibility of national regulations in this regard, or the optimization of the choice of air transport means.

The safety of transport by air is also supported by pedantic attention to details during the preparation of transportation, such as: the cleanliness of the transported freight, or its proper marking informing even about the way of handling a given cargo (marking the top of the cargo, its tolerance to the sun, etc.).

It should be emphasized that the current approach to transport safety and awareness of contemporary threats means that the dangers associated with the transportation of dangerous materials are constantly analyzed and reduced to an absolute minimum as experience is acquired.

BIBLIOGRAPHY

[1] AMC Affiliated contingency load planning workbook 36-101, USAFMOS/MOOO, 1 JAN 2015

[2] Biuro Bezpieczeństwa Narodowego, Polska w sojuszu północnoatlantyckim, [online]. Available at: https://www.bbn.gov.pl/pl/wydarzenia/15-lat-polski-w-nato/polska-w-sojuszu-polnoc/5295,Korzysci-i-inicjatywy.html [Accessed: 8 January 2023].

[3] Brodzik, R., 2020. Zagrożenia w drogowym transporcie materiałów niebezpiecznych, Lotnicza Akademia Wojskowa w Dęblinie, 2020.

[4] Dangerous Goods Regulation, 63rd Edition, IATA, 2022.

[5] Instrukcja przewozu materiałów niebezpiecznych wojskowymi statkami powietrznymi, DU--4.4.2.1(A), Warszawa 2020.

[6] Kalbarczyk, M., Kler, P., 2019. Bezpieczeństwo i możliwości przerzutu polskich kontyngentów wojskowych na duże odległości, GMiL, volume LXXI, 9/2019.

[7] Langowski, T., Langowski, Ł., Langowska H., Towary niebezpieczne w transporcie lotniczym, [online]. Availeble at: https://langowski.eu/towary-niebezpieczne-w-transporcie-lotniczym/ [Accessed: 2 April 2023].

[8] Preparing hazardous materials for military air shipments, AFMAN24-604, Department of the Air Force, 2020.

[9] Urząd Lotnictwa Cywilnego, Konwencje, [online]. Availeble at: https://www.ulc.gov.pl/pl/prawo/prawo-miedzynarodowe/206-konwencje, [Accessed: 3 April 2023].

[10] Urząd Lotnictwa Cywilnego, Materiały niebezpieczne, https://www.ulc.gov.pl/pl/prawa-pasazera/poradnik-dla-pasazerow/995-materiay-niebiezpieczne, [Accessed: 3 April 2023 r.].

[11] Ustawa z dn. 5 sierpnia 2022 r. o transporcie materiałów niebezpiecznych drogą powietrzną (DzU z 2022 r., poz. 1715) art. 1

[12] Zasady przewozu wojsk oraz sprzętu wojskowego transportem lotniczym, DD-4.4.2(B), Warszawa, 2020

[13] Zasady wykorzystania palet i kontenerów w Siłach Zbrojnych Rzeczypospolitej Polskiej, DD-4.4.8 (B), Warszawa 2017

[14] Żelazo, M., 2016. Bezpieczny transport materiałów niebezpiecznych drogą powietrzną, Wydział Zarządzania i Dowodzenia, AON, Zeszyty Naukowe 1(17)/2016.